



ENVIRONMENTAL ANALYSIS ASSOCIATES, INC.

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July 17, 2019

Mr. Brandon McWherter
Attorney at law
341 Cool Springs Blvd.
Suite 230
Franklin, Tennessee 37067

Re: Tim Morrison Project, EAA Project# 19-3187

Dear Brandon:

Per your request, I have been asked to provide my opinions regarding the fire residue sampling and analysis procedures used by GHP and EMSL on this project. My opinions are based on documents provided by your office (report of GHP dated September 18, 2018), existing industry accepted Microscopy methods, our own Standard Operation Procedures, and my own professional experience. Based on this information, the other party (GHP) collected surface dust samples by using an isopropyl alcohol wipe *“applied to a suspect surface”* and *“rubbed against the material in a circular pattern on an approximately 2 inch by 2 inch area”*. Wipe sampling is still being recommended by EMSL (the laboratory used by GHP on this project), even though this sampling procedure is not recommended by the most recent peer reviewed literature and analytical methods for the microscopic analysis of wildfire residues (*AIHA Technical Guide For Wildfire Impact Assessments*¹ published in April 2018). Wipe sampling (especially alcohol wipe sampling) alters and/or destroys the physical and chemical properties of char, ash, and soot particles. The use of water or other solvents (used by EMSL) in their preparation processes will also solubilize, alter, and remove the fire ash residues making them unrecognizable as discrete particles when using any type microscopic analysis (Optical, SEM, TEM) or dispersive X-ray analysis used for elemental identification. The sampling procedure described by GHP above will be even more destructive to particles collected on an alcohol wipe. As a result, their analytical results will significantly under report any fire-related particles and is inherently unreliable. My opinions and supporting information for these opinions are described in more detail below.

1.0 PROFESSIONAL BACKGROUND

Over the past 30 years I have performed several thousand indoor air quality and forensic environmental investigations in commercial, industrial, institutional, and residential dwellings. In 1976 I passed the board exam to become a Criminalist while working as a technician in the Scientific Investigations Division (SID) Criminalistics laboratory at the Los Angeles Police Department. Based on my specialized expertise in the analysis of physical evidence, asbestos, and aerosols using Optical Microscopy and Electron Microscopy, I

was selected in the mid 1980's by U.S. Environmental Protection Agency to serve on 3 different Select Panels for the development of asbestos sampling procedures, analysis methods, and Standard Operating Procedures for both Optical Microscopy and Electron Microscopy methods including (PLM, SEM and TEM). These committees resulted in the EPA publishing standard methods for bulk sample analysis by Polarized Light Microscopy (EPA/600/R-93/116 – “*Test Method – Method for the Determination of Asbestos in Bulk Building Materials*”⁶), and airborne asbestos analysis using Transmission Electron Microscopy (EPA 560-5-89-001, May 1989 – “*Guidelines for Conducting the TEM Clearance Test to Determine Completion of an Asbestos Abatement Project: Final Report*”⁷). In 2005, I served as a technical reviewer on the optical microscopy mold spore analysis method given in Chapter 7 of the 2nd edition of the AIHA Field Guide for the Determination of Biological Contaminants in Environmental Samples, published in 2005. This document was published by the American Industrial Hygiene Association Biosafety Committee. I am also one of several authors of the recently published 2018 “*AIHA Technical Guide for Wildfire Impact Assessments for the OEHS Professional*”¹.

I have also owned and/or managed several Analytical Microscopy and Chemistry laboratories that have been certified or accredited by the United States Environmental Protection Agency (USEPA), American Industrial Hygiene Association, and/or the California Department of Health Services. I have conducted several thousand Indoor Air Quality investigations involving allegations of asbestos, dust, microbiological contamination, fire/combustion residue, or related aerosols or bioaerosols. I have extensive research experience (field and laboratory) in Micropaleontology, Sedimentology, and the measurement of the atmospheric settling behavior of airborne aerosols. My own personal analysis experience is directly relevant to this case. I have personally analyzed several thousand surface and air samples for fire residue using both Optical Microscopy and Scanning Electron Microscopy.

My laboratory (Environmental Analysis Associates, Inc.) is an AIHA-LAP accredited laboratory for the microscopic analysis of mold spores. The laboratory provides day-to-day microscopy analysis of environmental and building generated aerosols, fire/combustion residue, bioaerosols, and materials analysis. I routinely provide consulting services regarding the interpretation and use of indoor air quality samples to building owners, health care facility managers, university environmental health and safety departments, and other environmental consultants. I own the patent on the design of the Air-O-Cell air sampling cassette manufactured by Zefon International. This device is the most widely used air impaction sampler in the United States and internationally for the analysis of airborne dust by Optical Microscopy and Scanning Electron Microscopy.

2.0 OPINIONS ON THE SAMPLING METHOD USED BY GHP

First, there are numerous published dust sampling protocols suited for the quantitative microscopy analysis of fire related soot, asbestos, and mold. All of these methods rely on the representative and uniform collection of dust through the use of adhesive tape, or vacuum dust samples. Wipe sampling is primarily recommended for collecting bulk dust samples being analyzed for organics, metals, and the identification of “carbon black” using Transmission Electron Microscopy. Wildfire residues are not carbon black. The quantitative collection of surface dust (for Microscopy Analysis) requires that the dust is representatively transferred from the sampled surface to the analysis media using an adhesion, impaction, or filtration procedure that produces a uniform deposition. This procedure must also minimize sample loss, alteration of the particle distribution, and retain particle integrity. Tape-lift¹ and micro-vacuum

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samples^{1,8} are best suited for this task. Tape-lift and micro-vacuum sample collection methods also prevent sample loss and through mechanical abrasion, variable size selection, and airborne cross-contamination during the sample collection process. These procedures are discussed on pages 6-10 in the *AIHA Technical Guide for Wildfire Impact Assessments*¹. GHP has chosen to use a wipe sampling procedure typically used for bulk chemical or metals analysis where retaining particle integrity is not critical. This procedure does not conform to recent AIHA¹ or IESO⁴ guidelines and ignores the significant sample alteration problems described above that makes this sampling protocol inherently unreliable. The chemical analysis of fire residue deposits can be analyzed from "bulk" and "wipe" samples as described above, however, quantitative microscopic analysis is performed based on a particle-by-particle analysis and not as a "bulk" chemical analysis.

In my opinion, the "wipe" sampling procedure used by GHP ensures that the particles being evaluated (wildfire soot, char, ash, indicator particles) will be destroyed, altered, under-represented, or not detected even if the fire residue was originally present. This reasons for this opinion are explained in more detail below.

1. First, rubbing the sampled surface in a circular fashion using an alcohol wipe (as described on page 2, paragraph 4 (Methodology) of the GHP report ensures the sample will not be representatively collected, nor will the size distribution of the surface dust be preserved in a consistent fashion from one sample to another sample. Using this procedure simply ignores the fact that fragile fire residue particles (mostly char, ash, and indicator particles) will be broken into smaller particles, or compacted into unrecognizable aggregates potentially making them invisible to Optical and Electron Microscopy analyses.
2. Soot particle clusters are very small when condensed or deposited on building surfaces (i.e. 5-50um). When subjected to a mechanical "rubbing" or abrasion action as described by GHP, they can break down into individual particles (0.05um to 1.0um) that are below the visual resolution of the Optical Microscope (i.e. ~1.0um). They can also be compacted and combined (aggregated) with other dust particles making them indistinguishable from other non-fire related debris. Using an alcohol wipe can also dissolve identifiable ash components or semi-volatile soot particles. When tape samples are taken directly from a "wipe" sample, the Optical Microscopy analysis is severely compromised because of these problems.
3. Furthermore, when compacted and agglomerated residues collected on wipe samples are ultrasonicated in a liquid to disperse the agglomerates (as performed by EMSL), the sample is further broken down or dissolved making the Optical and Electron Microscopy analysis of char, ash, and semi-volatile soot particles inherently unreliable.
4. Using this type of collection procedure simply ignores basic science and 30 years of peer-reviewed dust sampling procedures developed through scientific committees including the recently published AIHA Guidelines¹.

3.0 OPINIONS REGARDING THE EMSL SAMPLE PREPARATION AND WILDFIRE RESIDUE ANALYSES

As stated in the background section of this report, I am one of the authors of the 2018 AIHA Wildfire Assessment Guide. I was specifically chosen to write the microscopy sampling and analysis section of this document. I have been providing analysis of dust samples for over 30 years using Optical Microscopy, Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM). As described above, the analysis of dust samples (by any Microscopy method) is only as good as the representativeness and even distribution of dust on both the collection and analysis media. The analysis media must also provide an optimum background contrast so the analyst can easily see and distinguish individual particles that are not overlapping, and ensure particles have not been altered or selectively removed by the sampling process. The GHP and EMSL sampling and analysis procedures have not provided these required conditions.

1. First of all, there is no scientific way to directly perform a representative Optical or Electron Microscopy analysis of particles directly on wipe samples. The dust collected on wipe samples needs to be removed from the wipe and transferred to a different media for both the Optical and Electron Microscopy analyses. This process involves a second or third step where the dissolved (ash) or degraded (char and soot) components have potentially been removed or altered during both the initial sampling process, and then further degraded during the transferal to other analysis media.
2. Second, EMSL has failed to provide an industry accepted Standard Operation Procedure for any of their analysis procedures. As a result, there is no way for any investigator or another laboratory to know exactly how they performed their Optical or Electron Microscopy analysis in this case.
3. The main limitations of using Electron Microscopy (SEM or TEM) for fire residue analysis (soot, char, and ash) is that the image is not generated like a visual or optical image that uses light waves. The image is collected using transmitted electrons (TEM) or reflected electrons (SEM) produced in a chamber that is under vacuum. The result is that all particles appear as shades of gray and can only be visually differentiated based on their surface morphology and elemental chemistry by performing an X-ray analysis of each individual particle. This particle-by-particle Electron Microscopy analysis procedure was not performed by EMSL.
4. Another problem is fire-related soot particles can be semi-volatile and evaporate under the low vacuum required for the Electron Microscopy analysis. These semi-volatile particles can also be lost in the analysis by "heating or burning" under the high energy electron beam. This means that only an unknown smaller fraction of some fire-related particles will potentially remain on the collection media and potentially be visible (See pages 12-13 in the AIHA Technical Guide¹). When Electron Microscopy is utilized for the analysis of "non-volatile" soot particles (such as carbon black), the most appropriate imaging method to be used is Transmission Electron Microscopy and not Scanning Electron Microscopy. It is important to emphasize that wildfire and structure fire particles are not carbon black. The industry accepted procedure (for Transmission Electron

Microscopy) is outlined in the ASTM Method D6602 – 03b 2010. “*Standard Practice for Sampling and Testing of Possible Carbon Black Fugitive Emissions or Other Environmental Particulate, or Both*”⁵. Transmission Electron Microscopy (TEM) as used by EMSL is ineffective for the quantitative analysis of soot, char, or ash particles for some of the same reasons as the Scanning Electron Microscope. Even though the TEM can resolve smaller particles than Optical or Scanning Electron Microscopy, the use of wipe sampling and ultra-sonication in liquids will destroy and/or remove significant portions of fire-related or semi-soluble soot particles from the sample.

5. In my opinion, Scanning Electron Microscopy and dispersive X-ray analysis is very useful for differentiating corrosion and other “non-carbon” particles from the “larger” potential fire residue particles, primarily char and ash. In fact, my laboratory recommends and routinely uses high speed automated SEM particle analysis for classifying and measuring particles using size, morphology, and their elemental composition. However, the SEM/X-ray analysis of “wipe” samples as performed by EMSL does not retain the original morphology, distribution, or elemental chemistry, of individual particles as they were originally deposited on the surface. Any use of liquids used in wipe sampling preparation procedures will remove the characteristic salt components reflective of wildfire ash rendering the analysis inaccurate. Furthermore, the X-ray analysis of an individual field of particles collected on a carbon substrate (see pages 40 – 64 of the GHP report) is completely useless for the purpose of identifying the amount or concentration of potential fire residue particles in any sample. There is no way to differentiate the amount of carbon in an individual particle, from the carbon in the adhesive substrate. Furthermore, EMSL provides no explanation or guidance on how to interpret the bulk X-ray spectra they have provided on pages 40 – 64 of the GHP report. With EMSL’s failure to provide a Standard Operating Procedure (SOP), there is no scientific way to validate or even understand how they are using this data in their own laboratory reports.
6. The direct analysis of tape-lift samples is the preferred sampling method according to the AIHA *Technical Guide For Wildfire Impact Assessments*¹, pages 7-9 for both Optical and Electron Microscopy. The two main reasons are described below:
 - a. The sampling method preserves the larger condensate soot clusters (normally associated with indoor fires) intact so they can easily be detected and differentiated from the normal background of other fugitive sources.
 - b. The tape sampling method preserves the size, spatial orientation, and integrity of both char and ash components and allows the estimation of area % ratios and the numerical concentration in particles per unit area analyzed.

The tape lift sampling procedure was used by Alliance Consulting personnel to collect fire residue particle samples from this same project. These samples were subsequently analyzed by my own laboratory using Optical Microscopy. Example photos of soot, char, and ash particles using Optical Microscopy and SEM are given on page 10 of the AIHA Technical Guide¹ and provided below in Figure 5. The photos in the AIHA Wildfire Guide were provided by my laboratory. The pictures of

soot, char, and ash, in these photos are pure samples provided as examples in this report to illustrate the differences in imaging technique and particle morphology. The SEM “soot” photo (top and center) in Figure 5 required significant contrast enhancement including the complete removal of the gray background to make the aciniform cluster structure appear visible and clear. Finding soot in the background of other particles becomes very difficult. The “ash” SEM photo (center and bottom) shows the normal SEM image contrast typically found in a mixed dust sample. Soot particles are present, however they are practically invisible within the “ash” sample taken with SEM.

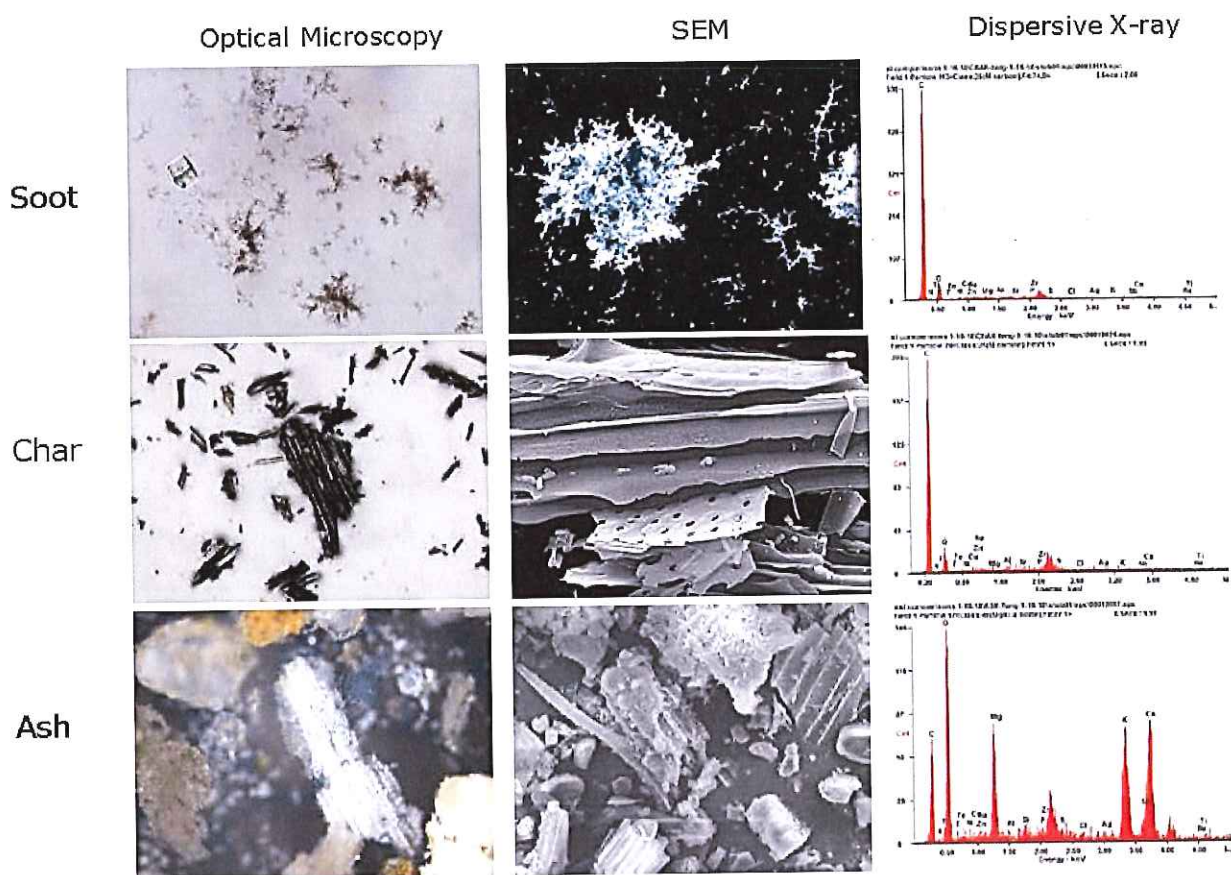


Figure 5 – Example of Optical Microscopy (Reflected Light/Dark Field), Scanning Electron Microscopy and Dispersive X-Ray Analysis of Wildfire Residue (Figure 5. AIHA Technical Guide¹).

7. I have provided a detailed explanation of the differences between Optical and Electron Microscopy below because EMSL has totally failed to explain how they use the electron microscopy methods within their own reports. In my opinion, these methods are ineffective at detecting the most common types of carbonaceous wildfire residue particles.

- a. The image generated in an Electron Microscope (SEM or TEM) is different than what our eyes see, or also what can be readily observed in an Optical Microscope. Although the image appears as black and white, it is based upon the energy and quantity of the reflected electrons to provide bright or dark areas within the image. The electron beam (unlike light

waves) will readily penetrate through small diffuse carbon particles (soot and small char) and produce a mixed image of both the particle, and material located below the particle surface. As a result, the image of the soot particles will appear gray, "fuzzy" and out of focus. Dense particles composed of heavier elements (e.g. aluminum, silicon, iron, etc.) will appear very bright (white) and exhibit a crisp and clear image. When looking for carbon soot or char particles on a carbon background the particles can essentially be camouflaged, practically invisible, and difficult to detect even if they are present. The only way to really "see" this type of small and diffuse particle in an SEM is to use a very low energy electron beam (i.e. 5-10KV), or use what is called a "Low-loss" image detection system. These are not standard procedures in most SEM laboratories. If the laboratory does not use this approach, it will not routinely see even the larger soot clusters (let alone the small sub-micron individual soot particles) when prepared on a carbon substrate media. In other words, *if you can't see it, you can't analyze it.*

- b. The reason why the Scanning Electron Microscope (see GHP reports pages 40-64) is an inappropriate tool for the quantification of fire residues (especially when the sample is initially collected on a wipe sample) is illustrated below with example micrographs (not from this project) that were appropriately collected using tape-lift sampling. The samples were photographed at magnification of approximately 50x using Reflected Light Dark Field Optical Microscopy. This is the accepted optical imaging method for detecting and quantifying fire residues and not Polarized Light Microscopy (as apparently used by EMSL). The exact same area was then photographed using the Scanning Electron Microscope at ~75x. Figure 6 is a photograph of soot / char sample collected using Reflected Light/Dark Field Optical Microscopy. Two crossed paint brush hairs (large straight fibers) were placed on top of the sample to act as size and location markers. The black aciniform soot and char particles are clearly visible (even at low magnification), and the area of the particles can be differentiated from other "non-fire" particles based on their "color" and morphology. The actual quantitative Optical Microscopy analysis is performed at magnifications from 200-500x.



Figure 6. Example photo - Reflected Light/Dark Field Optical Microscopy - ~50x

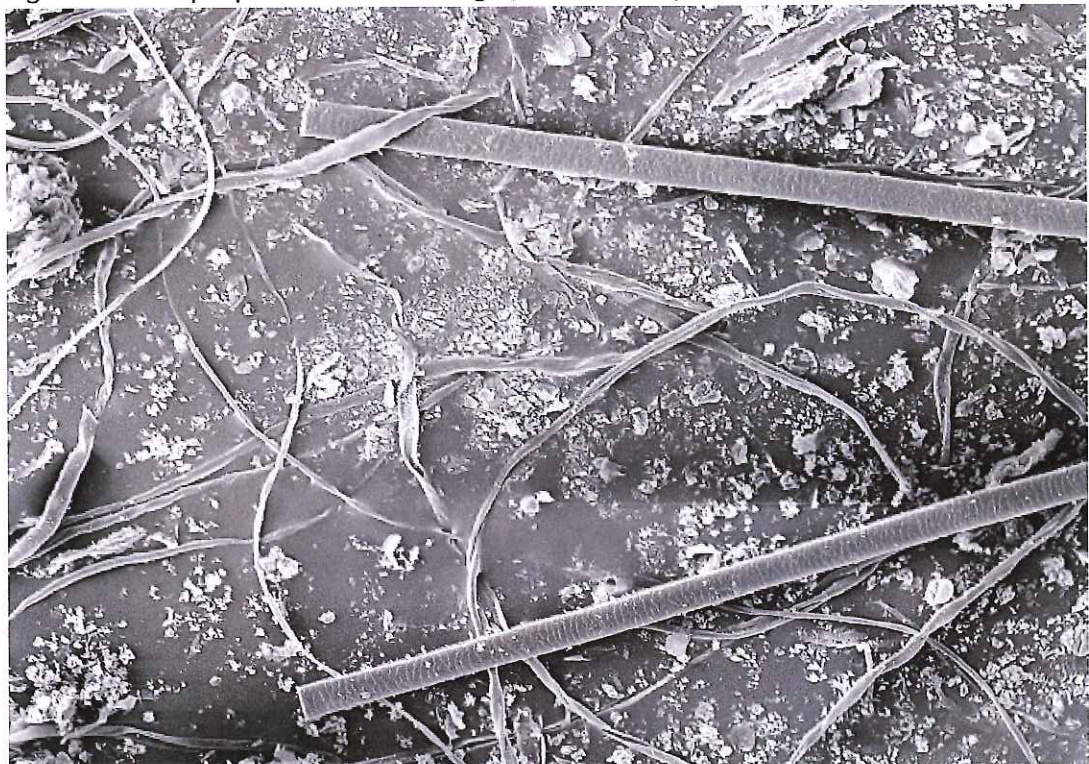


Figure 7. Example Photo of the same sample area - Scanning Electron Microscopy - ~75x

Figure 7 is a photo of the same sample area using Scanning Electron Microscopy. There is no way for the laboratory analyst to visually differentiate and estimate the area%, or the numerical concentration of fire-related soot or char particles based on the SEM image alone. Burned carbonaceous material (soot and char) appears visually "blackened" and is most easily recognizable by its surface morphology and color using reflected light / dark

field optical analysis. The areas of “black” soot/char material observed in the Optical Microscopy image (Figure 6), cannot be differentiated from any other particles in the sample when observed in the SEM image given in Figure 7.

Another example showing the limited ability of the SEM image to identify and differentiate particle composition by the image alone is shown in Figures 8 and 9. Figure 8 is an Optical Microscopy (reflected light / dark field) photograph of a charred wood particle where the burned “charred” surface of the wood can clearly be observed and identified as “char”.



Figure 8. Charred wood fragment - Reflected Light/Dark Field Optical Microscopy – ~50x

Figure 9 shows the exact same area of the same wood/vegetation (char) particle photographed using the Scanning Electron Microscope. It is impossible to visually identify or differentiate the “burned / charred” area of the wood fragment from a non-burned fragment in the SEM image or from an X-ray spectra by itself.



Figure 9. Charred wood fragment – Scanning Electron Microscopy (20kv) – ~50x

- c. Because of the visual limitations of the SEM image, it is impossible for the laboratory to determine the concentration % of fire residue, or to differentiate fire-related particles from other carbonaceous particles in the sample based upon a black and white SEM image, or a bulk dispersive X-ray analysis. Because of these limitations, it is inexplicable as to why EMSL provided the SEM and “bulk” X-ray spectra of entire fields of view (pages 40-64 in the GHP report) in the first place. There is no explanation in the GHP or EMSL report as to how the SEM analysis or optical analysis information is calculated or used together to determine the presence or absence of fire residue in these samples. On page 2, last paragraph of the GHP September 18, 2018 report, the report states “*Analytical procedures included: Polarized Light Microscopy (PLM), epi-Reflected Light Microscopy (RLM), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Energy-dispersive X-ray Spectrometry (EDX) and Electron Microscopy (ASTM D3849, ASTM D6602-13) to characterize particles in the submitted samples.*” This information is derived from the first page labeled as “Laboratory Report” (page 1 of 69) of the EMSL report dated 9/5/2018. Based on these statements and information provided in the EMSL laboratory reports, the analytical results appear to be derived entirely from the Optical Microscopy, however, there is no way to tell from the information provided within the laboratory reports. The reports vaguely reference a bulk X-ray for “*elemental composition*” at the bottom of each report page. EMSL has not provided an integrated procedure or method that shows how any of the Optical or Electron Microscopy data are integrated into a final report, or how the “*Concentration %*” is actually calculated. Furthermore, there are not any industry recognized “certificates of analysis” or signed reports for the SEM, TEM, or bulk X-ray spectra analyses. The EMSL reports contain sparse and inadequate information, and raises more questions than answers. A number of critical questions need to be asked in order for anyone to understand their report including but not limited to:

- What particles (analytes) were quantified by what specific microscopy method?
- What is the “Concentration %” in the report? Is it based on area%, numerical%, etc.?
- How is this percentage calibrated and calculated by the laboratory?
- How is the “Concentration %” of each different “analyte” calculated between Optical Microscopy, and Electron Microscopy?
- Does the laboratory have a flow diagram or actual procedure as to how and when each microscopy procedure is used in the final report?
- Where are calculations for each analyte? i.e. soot, char, ash, indicator particles and other environmental particles.
- Did the laboratory actually look for and report wildfire indicator particles (e.g. plant phytoliths, burned soil, burned grass char, burned pollen, etc.) that could actually be attributed to a vegetation fire?
- Where in their procedures is any of this information explained?

Obtaining the internal Standard Operating Procedure (SOP) of the method used by EMSL might help the investigator interpret their submitted results. SOP's are standard documents generated by scientific laboratories that describe their exact preparation and analysis methods. SOPs are a mandatory requirement of the scientific method, allow the laboratory results to be duplicated within the laboratory, and also be interpreted by a second laboratory. The information required in a laboratory SOP is summarized in a document published by the U.S. Environmental Protection (EPA/600/B-07/01. *Guidance for Preparing Standard Operating Procedures (SOPs)*, EPA QA/G-6⁹). My own laboratory's dust and fire analysis SOP is available upon request to our laboratory clients and has been provided in this case.

- d. Based on the limitations of the SEM images illustrated above, the only other way to differentiate burned char or soot particles from other particles, is by analyzing the elemental chemistry on a “particle-by-particle” basis using Energy Dispersive X-ray analysis. This analysis (even when using an automated SEM/X-ray analysis) is extremely limited for assessing carbon fire residue particles because the elemental composition of the carbonaceous soot and char particles and the background adhesive media are essentially the same (Carbon and Oxygen). EMSL has failed to describe how they used their SEM/X-ray analysis to differentiate carbon from non-carbon particles, and identify particles with a fire-related chemistry. Again, EMSL may be able to resolve this issue if they had provided an industry recognized SOP. The limitations of Electron Microscopy described above help explain why Optical Microscopy is the primary industry standard method for the analysis of fire residue particles including soot (item 8).

8. The “primary” industry accepted method for analyzing both wildfire and structure fire residue particles is Optical Microscopy (i.e. combined Bright Field, Polarized Light, and Reflected Light Dark Field). These methods are described in the AIHA¹ Guidelines as indicated above, and also in the

IESO guidelines "*IESO / RIA Standard 6001, Evaluation of Heating, Ventilation and Air Conditioning (HVAC) Interior Surfaces to Determine The Presence of Fire-Related Particulate as a Result of a Fire in a Structure*"⁴ on pages 11 and 12. Because Optical Microscopy uses light waves to observe the samples, the "color" of particles and the slight variations in light transmission and reflectivity enhance the ability to observe soot "clusters" and analyze subtle differences in char and ash particles as shown above in Figures 6-9. Additional example Optical Microscopy photographs from an example tape-lift sample and analyzed by Environmental Analysis are shown below in Figures 10 and 11. This sample was also determined by Environmental Analysis Associates, Inc. to contain high area percentages and numerical concentrations of fire residue particles.

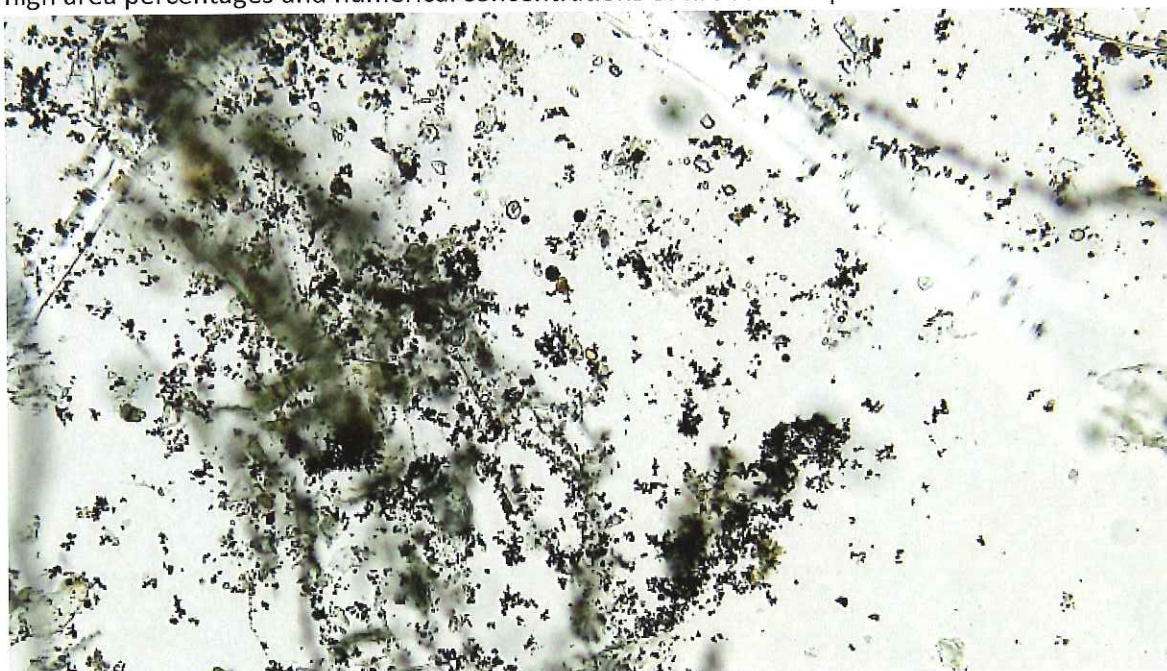


Figure 10 – Example Fine aciniform soot particles collected on a tape-lift sample, Transmitted Light Microscopy - 200x



Figure 11. Example fine aciniform soot particles collected on a tape-lift sample, Reflected Light/Dark Field Microscopy – 200x

Example Particle Field – (Figures 10 and 11) - shows a high concentration of aciniform soot clusters within a matrix of other carbonaceous biological debris. The soot clusters are easily visible using Optical Microscopy (Transmitted Light) at a magnification of 200x. Figure 11 is the exact same field-of-view using Reflected Light Dark Field Microscopy. Black carbon particles have a high opacity in transmitted light (Figure 10) and a very low reflectivity using Reflected Light Dark Field Microscopy (Figure 11). Optical Microscopy (when employing a wide range of illumination modes) can be used to rapidly and simultaneously switch back and forth in illumination modes to rapidly identify and quantify particles including combustion soot and char. As a result, fire-related particles (based upon optical and morphological properties) can be differentiated from other particles by absence of light reflectivity and/or their surface color and texture in reflected light. In other words, the “invisibility” of carbon particles using reflected light (as seen in Figure 11) is another identifying characteristic or analytical property of carbon soot and other diffuse carbon particles. Other similar appearing particles of different composition such as iron oxide or paint would still be visible and appear colored or white if present. As can be observed, there are several spherical (white) particles visible in Figure 11 that are consistent with paint. Just as importantly, estimates of the concentration percentages (area%, numerical %) of each particle or analyte category can be quickly ascertained

4.0 ANALYSIS METHODS USED BY ENVIRONMENTAL ANALYSIS ON THIS PROJECT

Environmental Analysis Associates provided the analysis of tape-lift samples collected for fire residue analysis by Alliance Environmental Consulting on this project. These samples were quantitatively analyzed using a full range of simultaneous Optical Microscopy procedures (Bright field, Polarized Light, and Reflected Light / Dark Field). Our reports provide a complete certificate of analysis and guidelines for the

interpretation of our analysis reports. Our 60+ page Standard Operating Procedure for these analyses is provided as a separate document. Our methods follows ISO, AIHA, as well as EPA guidelines for analysis method documentation and precisely describes all of our preparation, calibration, particle classification, analysis, calculation, and reporting procedures.

5.0 CONCLUSIONS

The sampling and analysis methods employed by GHP and EMSL do not follow industry recognized guidelines and their results cannot be validated or compared with data collected by other laboratories. The procedures they have used, in my opinion will be inaccurate and under report the concentration of fire related particles.

1. The "wipe sampling" procedure chosen by GHP is by design, ineffective at collecting fire-related particles in any uniform fashion. Using wipe sampling ignores both recent existing peer-reviewed methods, and other optical microscopy methods developed over the past 30+ years.
2. The primary industry accepted and most accurate method for collecting and analyzing surface fire residue samples is tape lift sampling. The most accurate method for analysis and quantitative measurement of fire residue particles is the direct Optical Microscopy analysis of tape lift samples. Specifically, this analysis requires a simultaneous and systematic combination of transmitted light, polarized light and most importantly, reflected light / dark field imaging methods.
3. Scanning Electron Microscopy is only useful when using an instrument equipped with automated particle analysis capabilities for the differentiation and classification of individual particles. This specifically means the individual particle chemistry also needs to be differentiated from the carbon substrate background. The SEM X-ray spectra provided by EMSL contain the elemental composition of the entire field of view (including the carbon substrate background). This analysis provides no real analytical value for the identification of fire residue particles including soot, char, or ash. As a result, the SEM data is essentially useless as provided in the GHP report.
4. EMSL has apparently used a variety of optical and electron microscopy methods to arrive at a conclusion of "not detected", for a majority samples analyzed for GHP. However, there is no explanation as to how these procedures and results are linked together in any scientific or coherent way that would allow for a useful or understandable conclusion. Without providing an industry accepted Standard Operating Procedure, (SOP), the EMSL analysis procedures cannot be independently evaluated. EMSL is "accredited" by the AIHA-LAP programs for a range of analytes using Optical Microscopy. As a direct requirement by the International Standards Organization (ISO) guidelines (used by the AIHA-LAP accreditation programs), their laboratory is required to have an industry accepted SOP for each type of analysis performed by their laboratory, including fire residue or particle analysis. An SOP is not a "proprietary" document and must be made available to clients using their laboratory.

In summary, the sampling and analysis procedures used by GHP and EMSL in my opinion are inadequate, non-verifiable, and will significantly under-report the combustion / fire-related particles they are supposedly analyzing. Even if fire residue particles are detected, the reported concentration percentages

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cannot reliably be interpreted or directly compared with data collected by any other laboratory. As a result, their results are inherently unreliable.

If you have any questions regarding my response, please contact me and 858-272-7747.

Environmental Analysis Associates, Inc.

Daniel M. Baxter

Daniel M. Baxter
President

REFERENCES

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